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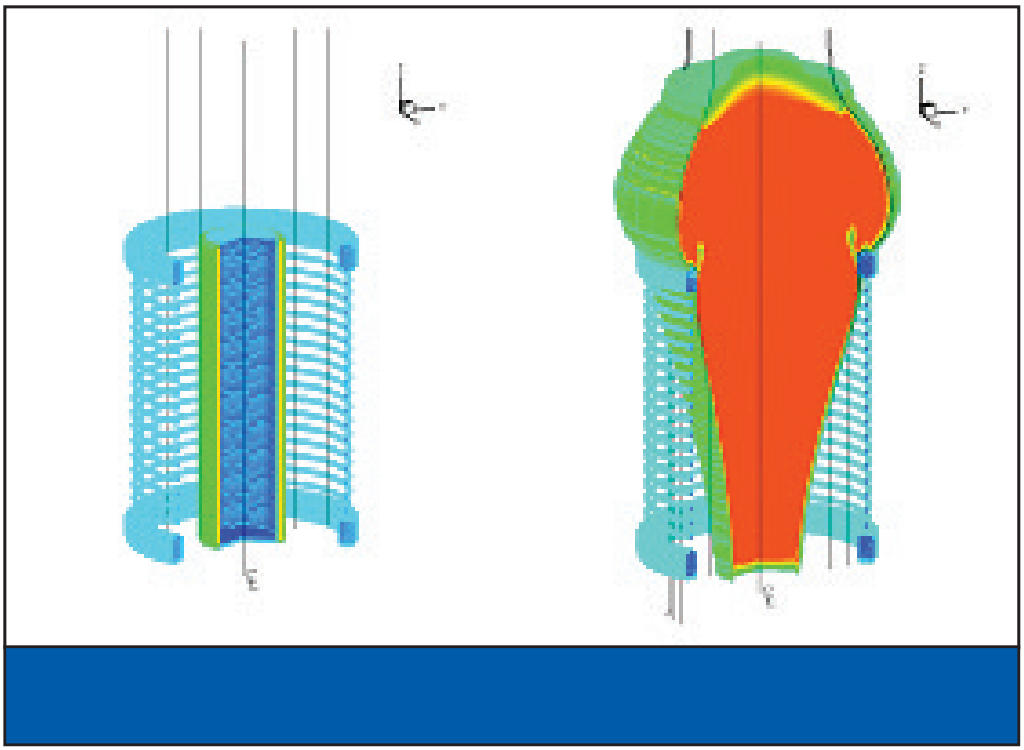
Success Story

MULTIBLOCK ARBITRARY COORDINATE HYDROMAGNETICS IN THREE SPATIAL DIMENSIONS



Multiblock Arbitrary Coordinate Hydromagnetics in three spatial dimensions (MACH3) is a three-dimensional (3-D) magnetohydrodynamics (MHD) code specifically designed to execute on parallel high-performance computing resources. MACH3 solves the continuum equations for conducting materials that are in the solid, liquid, gas, or plasma states. The software has advanced numerical methods for computing the time evolution of a magnetic field and its influence on the materials in the simulation.

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Accomplishment

The Directed Energy Directorate's High-Power Microwave Division is developing a general-purpose physics simulation code known as MACH3 to solve the unsteady, non-ideal MHD equations in complex geometries. The researchers used a structured, arbitrary coordinate 3-D grid for the 3-D version of this software based on the 2½-dimensional predecessor code MACH2.

The MACH3 design allows researchers to divide and distribute extremely large computational domains into blocks, which are distributed across multiple computer processors and share common boundary information via the message passing interface standard. MACH3 can execute on the largest distributed memory multiple processor computing machines available.

Background

During 2001, researchers used the 2½-dimensional predecessor software at over 40 government, university, and contractor institutions. The code demonstrated 3-D time-dependent simulations of an explosive magnetic flux compression generator (MCG). An MCG is a compact, pulsed power driver for numerous directed energy concepts.

In addition, researchers conducted 3-D time-dependent simulations of fast z-pinch experiments. Z-pinches generate powerful X-ray pulses for a variety of laboratory applications. The researchers also used the code for two-dimensional (2-D) time-dependent simulations of solid shell implosions. Such implosions can create extremely high pressures that researchers use to investigate the behavior of matter under extreme conditions.

Finally, researchers used MACH3 for 2-D and 3-D time-dependent simulations of high-speed flows in the presence of plasma. Such flows offer the potential to change the aerodynamics of hypersonic vehicles.

The fully 3-D code is under development with funding from the Department of Defense High-Performance Computing Modernization Office (HPCMO) and from the Air Force Office of Scientific Research. The directorate's High-Power Microwave Division's high-performance computing team consists of government researchers and on-site contractors from NumerEx (a subcontractor to Science Applications International Corporation) to assist in the development of MACH3. Furthermore, the HPCMO provides high-performance computing resources for the development and application of MACH3.

Directed Energy
Emerging Technologies

Additional information

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